
Space Weather Technical Forecast

Issued on Sunday, 18 December 2022 at 13:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-class flares Likely. Slight Chance of Minor Geomagnetic Storms throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with peak activity recorded at GOES16 being an M1.0 flare seen at 17/1953UTC from AR3169 near the northeastern limb. There are currently eight numbered sunspot regions on the Earth-facing side, with AR3165 transiting round the southwest limb to the far side. However, this has been replaced in the southeast by newly-designated AR3170, which currently presents as Cao/Beta, but is very likely hiding some complexity. The same is likely to be true of AR3169 in the northeast, with this group currently analysed as an Eso/Beta.

Many of the remaining regions were unipolar and stable or relatively simple bipolar regions with no significant changes, although AR3166 saw penumbral growth and in its intermediate spots to become Dsi/Beta and AR3163 saw areal growth in its leading spots to become Eki/Beta. Meanwhile AR3167 experience decay, reducing in size to become Cao/Beta.

No new Earth-directed CMEs are confirmed at the time of writing, although eruptions from near the southwest limb at around 18/0600 UTC and from AR3162 at 18/1010 UTC are currently being analysed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR remained at ambient levels, ranging from 270-350 km/s. The solar wind density was near the long-term average of single figures ppcc throughout, while the IMF was stable at or below 8nT, with a north-south component varying between +6 and -4nT. The phi angle was mostly negative (towards the Sun).

The net result of the above solar wind measures was for Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.

High energy electron flux (greater than 2 MeV), as observed by GOES16, was at Background to Moderate levels. The associated 24-hour fluence was roughly level and well below Active (1e8 integrated pfu). Observed fluence at 18/0001UTC was 2.06e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain at Moderate levels, particularly at first, with AR3165 only recently transiting round the southwest limb. Arriving AR3169 appears to be capable of similar levels of activity, and far side soundings as well as recent far-sided CMEs suggest that there may be a large region nearing the northeastern limb into the UTC week, perhaps preserving the risk of further M-class flares.

Solar Wind / Geomagnetic Activity: Two CMEs may give slight glancing impacts on days 1 and 2 (18th and 19th), although confidence in this aspect of the forecast is notably low. Otherwise, solar winds are expected to follow a slow regime initially, perhaps becoming slightly elevated as CH54/- potentially affects Earth later on day 1 (18th) but more likely day 2 (19th). A second fast wind from CH55/+ is then likely to feature on day 4 (21st).

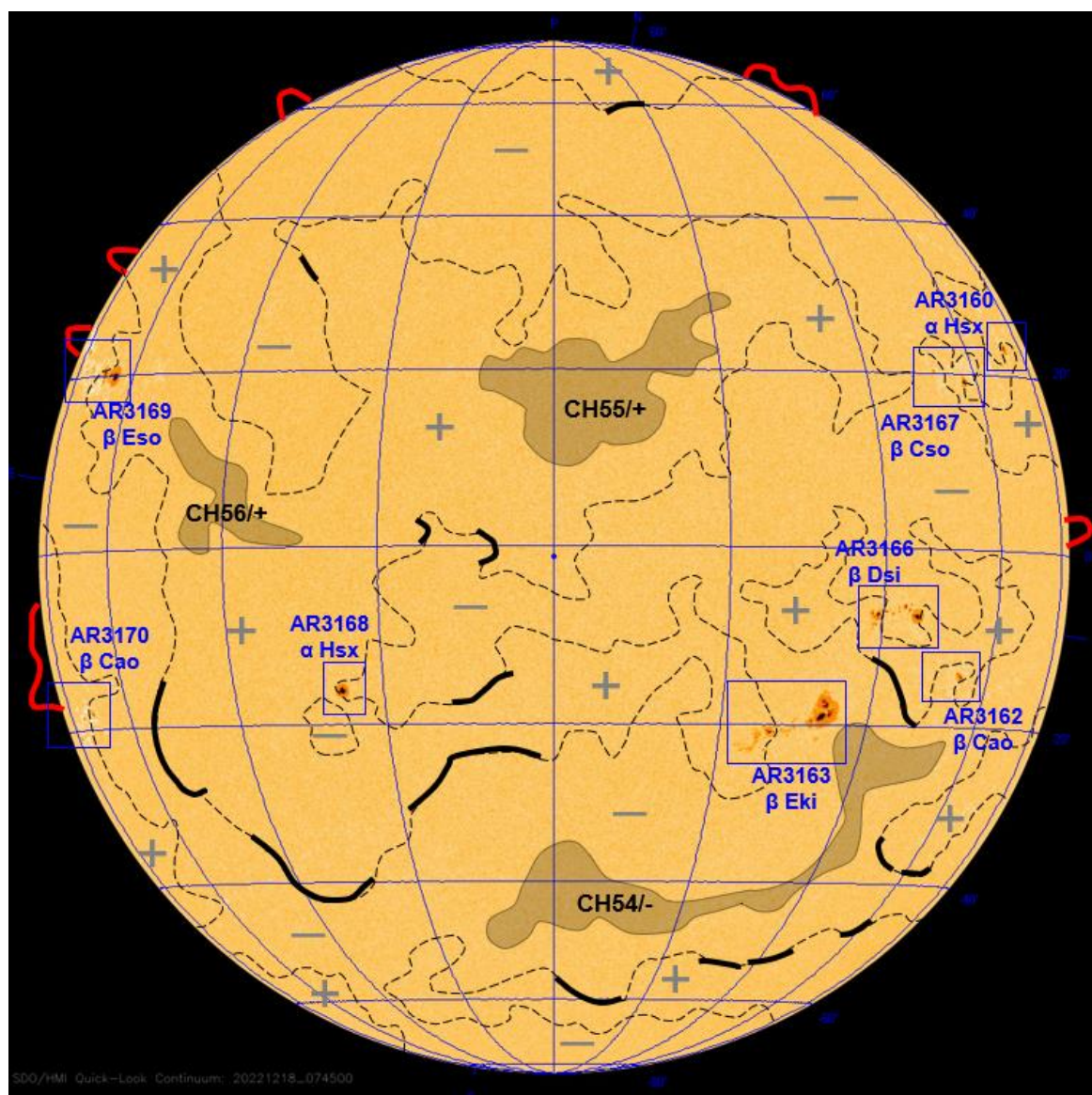
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The above combination of low confidence CME activity and two successive fast wind streams should combine to give a daily Slight Chance of G1, with day 3 (20th) looking like the best chance of background conditions.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels throughout, although there is slight chance of S1 level storms with the occurrence of any notable flares.

High energy (greater than 2 MeV) electron flux is currently at Background to Moderate flux levels and expected to persist at these levels. The associated 24-hour fluence is expected to continue well below the Active (1e8 integrated pfu) threshold with a mostly flat trend anticipated.

Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Two minor Coronal Mass Ejections (CMEs) may feature in this four-day forecast period. The filament lift off from the southwest around 14/0300UTC has been assessed as missing Earth, but brings a slight chance of glancing impacts during Sunday 18 December. Similarly, a CME which left the Sun on 15 December is also assessed as missing Earth, though it may have minor glancing impacts later on Sunday or perhaps into Monday 19 December.

Up to two fast wind streams may also feature in the coming four days. While Earth is currently transiting a sector of space characterised by a slow solar wind, CH54/- may feature from late on day (18th), but more likely on day 2 (19th). Persistence would suggest arrival on day 1 but the feature is reduced in size and northward extent compared to the previous rotation and it is only just appearing at STEREO A, thus an arrival on day 2 is preferred with speeds only peaking as slightly elevated.

A lull in the solar wind speed is temporarily likely on day 3 (20th), ahead of another coronal hole fast wind enhancement on the day 4 (21st) from CH55/+, bringing elevated wind speeds.

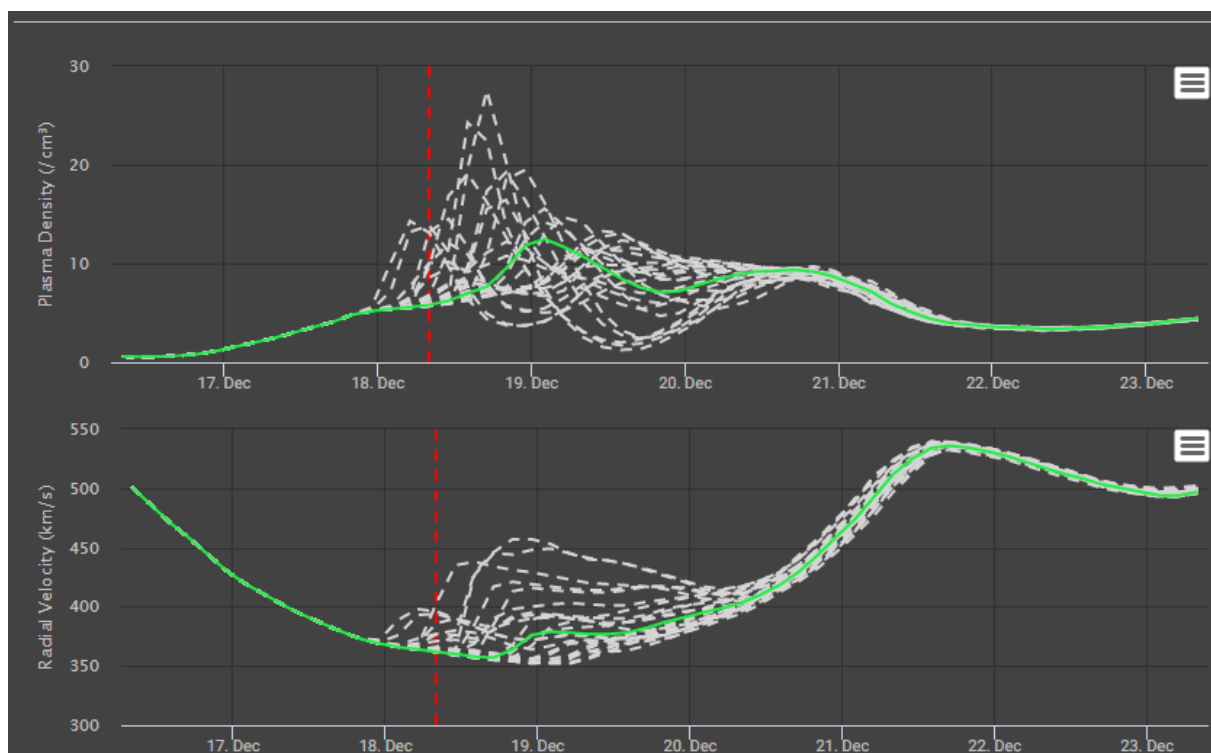
All considered, there is a residual Slight Chance of G1 throughout given the multitude of low confidence events: starting with CH54's fast wind and up to two CMEs, probably giving way to a brief lull most likely on day 3 (20th), before a second fast wind arrives midweek.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	15	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1530	Partial	Filament	SW	400	Early 18th	Low confidence
15/1743	Partial	Unknown	NE	790	18 th into 19 th	Low confidence

Figure 2: Enlil ensemble showing spread of coronal hole and CME enhancements over the coming days with CH55/+ the most likely on day 4 (21st).



Radio Blackouts - X-Ray Flares:

There are now eight numbered sunspot regions on the visible disc, with AR3165 recently transferring round the southwest limb to the far side. The Earth-facing side is made up of unipolar and bipolar regions, with changes in the larger groups of AR3163; AR3166, AR3167 and AR3169 generally slow and not productive in terms of larger flares.

The front-side population of sunspot groups is likely to be in a state of flux through the forecast period. In the immediate term, the daily risk of flares should decrease as AR3165 continues to transit to the far side, followed by the departures of AR3160, AR3162 and AR3167 later in the period. In terms of sustaining risk, the arriving eastern limb groups of AR3169 and AR3170 may well be hiding detail, and it is very possible that a large region suggested by far-side soundings and some halo CMEs of the past week may arrive into the UTC working week to bolster the otherwise falling risk of significant flares, with this contribution yet to be determined.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	50	50	50
Very Active	R3 to R5 X Class	No	10	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) will most likely continue at Background levels, however there is a slight chance throughout of a S1+ event. This chance is slightly increased on day 1 and 2 (18th and 19th) against the raw probabilities for the disc due to the presence of AR3165, which has just transferred round the southwest limb to the far side. There is also the possibility of an increase in probabilities later in the period with recent far-sided CME and flare activity approaching the east limb, but this will be assessed in due course.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	15	10	10
Very Active	≥ S3 [*]	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux is following a stable low magnitude diurnal oscillation at present. Whilst CH54 and CH55 may become geoeffective in turn in the period, neither is currently envisaged as being capable of giving Active 24-hour integrated fluence, as per previous rotations. Confidence in this is perhaps lower than average, with both of these coronal holes' geometries changed since last pass, as well as the possible complicating presence of up to two CMEs. For its part, MOSWOC REFM suggests current modest electron fluence levels should persist throughout, although this does not allow for any transient activity.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	5	10	20
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1